New ionic liquids based on complexation of dipropylsulfide and AlCl$_3$ for electrodeposition of aluminum

Youxing Fang, Xueguang Jiang, Xiao-guang Sun$^*$ a and Sheng Dai$^*$ ab

Materials and experiments

Granular AlCl$_3$ was purchased from Sigma-Aldrich and used as received. Dipropyl sulfide (DPS) was obtained from TCI chemical company. In Ar-filled glovebox, a desirable amount of AlCl$_3$ is added into DPS in a sealed vessel with a magnetic stirring bar. The reaction is slightly exothermic so it is not necessary to heat the vessel to accelerate the dissolution of AlCl$_3$.

The differential scanning calorimetry (DSC) profile was acquired from NETZSCH (STA 409 PC) under argon environment. The mass spectrum analyses were performed using a JEOL AccuTOF-D time-of-flight (TOF) mass spectrometer with a DART (direct analysis in real time) ionization source from JEOL USA, Inc. Fourier transform infrared data were gathered from Perkin-Elmer Fourier-transform infrared spectrophotometer. The electrochemical experiment was performed on CHI600D electrochemical analyzer. SEM images are obtained by Hitachi S-4800 FEG scanning electron microscope with the EDS attachment.

For cyclic voltammetry, a clean platinum electrode (0.5 mm in diameter) was used as working electrode, with Al sheet and Al wire as the counter and reference electrode. For electrochemical plating, a polished and cleaned Cu strip was used as cathode with Al plate as the anode. The plating bath was held on a hot plate with temperature control and stirring.

Supplementary figure

![DSC thermograms](image.jpg)

**Figure S1** DSC thermograms of the ionic liquids with different ratios of DPS/AlCl$_3$ at
a heating rate of 10 °C /min under nitrogen. (Note: the lines have been shifted perpendicularly for clarity).